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CERTIFICATION OF ATTACHED ENGLISH TRANSLATION OF PCT APPLICATION:

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I hereby certify the English translation attached is a true and accurate copy of the referenced PCT/EP2004/053358 application.

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REFRIGERATING UNIT COMPRISING AN ULTRASOUND-WELDED SUCTION TUBE AND A THROTTLING TUBE

[001] The present invention relates to a refrigerating unit comprising a throttling tube and a suction tube for refrigerant. The throttling tube runs at least over a part of its length inside the suction tube and emerges from the suction tube to form an outlet location. Furthermore, the throttling tube and the suction tube are joined to one another at another second location of the suction tube at which outer surfaces of the throttling tube and the suction tube are in contact. The invention further relates to a method for joining the throttling and suction tubes.

[002] In household appliances, the throttling tube is usually guided inside the suction tube before entry into the evaporator and is passed further inside the suction tube as far as the evaporator. Pre-cooling of the liquefied refrigerant guided in the throttling tube is hereby achieved through heat exchange with the evaporator refrigerant which is sucked out in the suction tube. The suction tube and the throttling tube are usually joined together in a liquid- and gastight manner by soldering at this first location of the suction tube at which the throttling tube is guided inside the suction tube. The structure of the material from which the throttling tube is made, usually copper or a copper alloy, is modified by the soldering so that the throttling tube would easily kink without further fixing. For this reason, the portion of the throttling tube located outside the suction tube before entry into the suction tube is usually guided parallel to the section tube over a certain length and is fixed to the suction tube with adhesive tape. The adhesive tape is usually applied by hand.

[003] Another possibility for fixing the throttling tube to the suction tube would be to wind the throttling tube around the suction tube. However, this could result in undesirable noises.

[004] It is the object of the present invention to provide a refrigerating unit of the type specified initially wherein the throttling tube guided into the suction tube is protected from kinking at the location of entry into the suction tube in a simple and cost-effective manner.

[005] The object is solved by a refrigerating unit according to claim 1 and a method for joining the suction and throttling tubes of a refrigerating unit according to claim 7. The dependent claims relate to preferred embodiments of the refrigerating unit.

[006] Accordingly, a refrigerating unit comprising a throttling tube and a suction tube for refrigerant are provided wherein the throttling tube is guided inside the suction tube at a first location of the suction tube and is joined thereto and wherein the throttling tube and the suction tube are joined to one another at another second location of the suction tube at which outer surfaces of the throttling tube and the suction tube are in contact. According to the invention, the outer surfaces of the throttling tube and the suction tube are joined to one another at the second joining location by ultrasound welding.

[007] The ultrasound welding usually takes place so that the outer surfaces of the suction and throttling tubes to be joined are brought into contact with one another and excited by high-frequency ultrasound. In this case, the frequencies can lie in the range of about 20 000 to 60 000 Hertz. The two surfaces of the suction and throttling tubes rub against one another and are heated so severely that their contact surfaces fuse together. The ultrasound energy is usually supplied to the tubes to be joined by means of a so-called sonode. The sonode amplifies the ultrasound produced by a composite piezo oscillator, for example. A composite piezo oscillator is usually composed of a plurality of piezo-ceramic perforated disks which are clamped to one another by means of metal end pieces.

[008] The welding of the suction and throttling tubes by means of ultrasound welding has the advantage that the heat required for the welding is released in a short time and exclusively localised on to the surfaces of the two tubes in contact with one another. Other regions of the tubes are at most heated by heat flow from the region of contact. They thus remain substantially cooler than is possible by soldering, for example. Consequently, the structure of the metal material forming the suction tube and the throttling tube, this usually being copper or a copper alloy, does not change decisively. The mechanical strength properties of the material are thus not modified. In addition, this is a very cost-effective joining technique. In

addition, the fixing of the throttling tube on the suction tube by means of ultrasound welding can be automated, which is not the case with fixing using adhesive strip. At the present time, this must still be applied by hand. The omission of the adhesive strip also brings about a saving of material.

[009] The second location at which the outer surfaces of the throttling and suction tubes are joined together is preferably about 5 mm to 20 mm, especially about 5 mm to 15 mm, more especially about 10 mm from the first location at which the throttling tube enters inside the suction tube.

[010] The throttling tube can be inserted in various ways inside the suction tube. For example, the suction tube can have a cut or an entrance hole for the throttling tube in its wall. It is also possible to provide a connecting tube which has a connecting point for an end of a first part suction tube and a throttling tube on one side and is therefore expanded. The second part suction tube and the throttling tube are inserted in the expansion. Another possibility is to provide one of the part suction tubes with a cover at one of its ends which has an insertion hole for the second part suction tube and an entrance hole for the throttling tube. In the case of an expansion, the suction tube has a larger diameter at the first location than at the second location.

[011] When the throttling tube is guided in the suction tube immediately before the evaporator, the liquefied refrigerant guided in the throttling tube towards the evaporator is pre-cooled by means of heat exchange with the evaporated refrigerant removed in the suction tube from the evaporator. Consequently, the second location at which a portion of the throttling tube located outside the suction tube is fixed to the suction tube by ultrasound welding, is preferably located downstream from the first location at which the throttling tube enters into the suction tube with reference to the refrigerant flowing in the suction tube.

[012] The refrigerating unit according to the invention can, for example, be a refrigerator or freezer, for example, for domestic use.

[013] The present invention also comprises a method for joining a suction tube of a refrigerating unit to a throttling tube. The method comprises the following steps: guiding the throttling tube out from the inside of the suction at a first location which serves as an outlet location of the suction tube; joining the suction tube and the throttling tube at the first location, especially by soldering; bringing in contact an outer surface of a portion of the throttling tube located outside the suction tube with an outer surface of the suction tube at a second location of the suction tube; joining the suction tube and the throttling tube at the second location. In this case, the outer surfaces of the suction tube and the throttling tube are joined to one another by ultrasound welding. These process steps are preferably carried out in the order specified hereinbefore. However, it is also possible to carry them out in a different order. For example, the throttling tube can first be inserted inside the suction tube, then the throttling tube can be fixed on the suction tube by means of ultrasound welding for subsequent protection from kinking and then the throttling tube and the suction tube can be joined to one another at the point of entry of the throttling tube into the suction tube, which is preferably carried out by soldering.

[014] Further features and advantages of the invention are obtained from the following description of an exemplary embodiment with reference to the appended drawings. In the figures:

[015] Figure 1 is a sectional view showing a portion of the evaporator 1 with a throttling tube 1 which supplies a refrigerant and a suction tube 2 which removes the refrigerant and the joining of the two tubes before the evaporator 1.

[016] Figure 1 shows a throttling tube 1 and a suction tube 2 of a refrigerating unit according to the invention. The refrigerating unit itself is not shown since its structure is known to the person skilled in the art. The refrigerating unit can be a refrigerator for example. The throttling tube 1 guides liquefied refrigerant to an evaporator 3 of the refrigerating unit. Said throttling tube 1 opens into a refrigerant tube 4 of the evaporator 3, which extends in a meander fashion over the entire area of the evaporator 3, as cannot be seen from the section shown. The end of the refrigerant pipe 4 discharges into a connecting section 5 of the

evaporator 3 in which the suction tube 2 is inserted and fixed. The suction tube 2 guides the evaporated refrigerant away from the evaporator 3. The suction tube 2 and the throttle tube 1 are each thin-walled tubes having an inside diameter of a few millimetres in the case of the suction tube 2 and fractions of a millimetre in the case of the throttling tube 1.

[017] Before the evaporator 3 the throttling tube 1 enters into the suction tube 2 at a first location A of the suction tube 2 and is guided as far as the evaporator 3 in the suction tube 2 until this ends in a connecting section 5 of the evaporator 3. By guiding the throttling tube 1 in the suction pipe 2, the liquefied refrigerant guided in the throttling tube 1 is pre-cooled by heat exchange with the evaporated refrigerant in the suction tube 2 which has been removed by suction. In the embodiment shown, the suction tube 2 is formed from at least two part suction tubes 9 and 10 which are joined to one another in a liquid- and gastight manner by a connecting tube 11. The part suction tube 10 connected directly to the evaporator 3 is connected at one of its ends to the connecting tube 11 which has a first location A which is expanded and has an outlet point for the throttling tube. The part suction tube 9 and the throttling tube 1 are inserted in the expansion. The part suction tube 9 ends in the expansion. The throttling tube 1 guided further in the part suction tube 10 as far as the evaporator 3. The part suction tube 9 and the throttling tube 1 are joined tightly to the part suction tube 10 by soldering at the expansion of the connecting tube 11.

[018] Unlike the figure shown, an embodiment is also feasible where the throttling tube 1 is guided into the suction tube 2 at the location A in the suction tube 2 through a cut or an entrance hole located in the wall of the suction tube 2 or the connecting tube 11. The suction tube 2 could then be embodied as one piece. It would also be feasible to provide the connecting tube 11 at the first location A with a cover which has two through holes, one for inserting the part suction tube 9 and one for inserting the throttling tube 1. In this case, the throttling tube 1 and the suction tube 2 would also be joined together by soldering at the entrance point of the throttling tube 1 into the suction tube 2.

[019] The suction tube 2 and the throttling tube 1 usually consist of copper or a copper alloy. During soldering the structure of the copper material is changed, resulting in a deterioration in

the strength properties of the copper material. Under mechanical stressing, the throttling tube 1 can thus easily kink at the soldered entrance point into the suction tube 2. In order to avoid this, the throttling tube 1 is fixed to the suction tube 2 at another second location B by means of ultrasound welding. At this point B, the throttling tube 1 is located outside the suction tube 2. In the embodiment shown the second location B of the suction tube 2 is located downstream from the first location A of the suction tube 2 with reference to the refrigerant guided in the suction tube 2. Advantageously, the first location A and the second location B are about 5 mm to 20 mm, preferably about 5 mm to 15 mm and especially preferably about 10 mm apart.

[020] The throttling tube 1 and the suction tube 2 can be joined at the two locations A and B as follows: at the location A the throttling tube 1 is guided out from the inside of the suction tube 2 and joined to this by soldering. An outer surface of a portion of the throttling tube 1 located outside the suction tube 2 is then brought in contact with an outer surface of the suction tube 2 at the location B, i.e. the throttling tube 1 is placed against the suction tube 2. The outer surfaces of the throttling tube 1 and suction tube 2 are joined together by ultrasound welding. This is achieved by excitation with high-frequency ultrasound. The frequencies can lie in the range of about 20 000 to 60 000 Hertz. Excited by the ultrasound, the surfaces of the throttling tube 1 and the suction tube 2 rub against one another and are heated so severely that their contact surfaces fuse together. The ultrasound energy is usually supplied by means of a so-called sonode. The sonode amplifies the ultrasound produced by a composite piezo oscillator, for example. A composite piezo oscillator can be composed of a plurality of piezo-ceramic perforated disks which are clamped to one another by means of metal end pieces.

[021] The process steps described hereinbefore for joining the throttling tube 1 and the suction tube 2 at the locations A and B can take place in a sequence other than that described. For example, it is feasible to first guide the throttling tube 1 out from the suction tube 2 at location A, then fix the throttling tube 1 on the suction tube 2 at location B by ultrasound welding and only then solder together the throttling tube 1 and the suction tube 2 at location A.